Sensing Hazards with Operational Unmanned Technology (SHOUT)

SHOUT-HRR Dropsonde Data Quality Report

January 03 2017

The dropsonde data for this project were quality controlled and are maintained by the Earth Observing Laboratory at the National Center for Atmospheric Research (NCAR). NCAR is sponsored by the National Science Foundation (NSF). In the event that information or plots from this document are used for publication or presentation purposes, please provide appropriate acknowledgement to NSF and NCAR/EOL and make reference to Young K. and H. Vömel (2017): SHOUT-HRR Dropsonde Data Quality Report.

In the event that these datasets are used for research resulting in a publication, please include the following citations in your paper:

UCAR/NCAR - Earth Observing Laboratory. 2016. SHOUT-HRR Global Hawk QC Dropsonde Data. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.5065/D6MP51PP. Accessed 06 Jan 2017.

SHOUT-HRR Quality Controlled Dropsonde Dataset

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I. Dataset Overview

The Sensing Hazards with Operational Unmanned Technology (SHOUT) was a multi-agency, multi-phase research campaign aimed at using targeted measurements to improve weather model forecasts. The first phase, called SHOUT, took place in the Fall of 2015 over the Atlantic Ocean. The second phase, referred to as SHOUT El Nino Rapid Response (SHOUT-ENRR), took place in the Spring of 2016 over the Pacific Ocean. The final phase, SHOUT Hurricane Rapid Response (SHOUT-HRR) was conducted over the Atlantic Ocean between August 24 and October 9, 2016. Six hundred and thirty four dropsonde soundings were collected from the NASA Global Hawk during nine research flights (Table 1). This document contains information on the project and details regarding the quality control procedures

For more information on the SHOUT project please visit: https://uas.noaa.gov/shout/

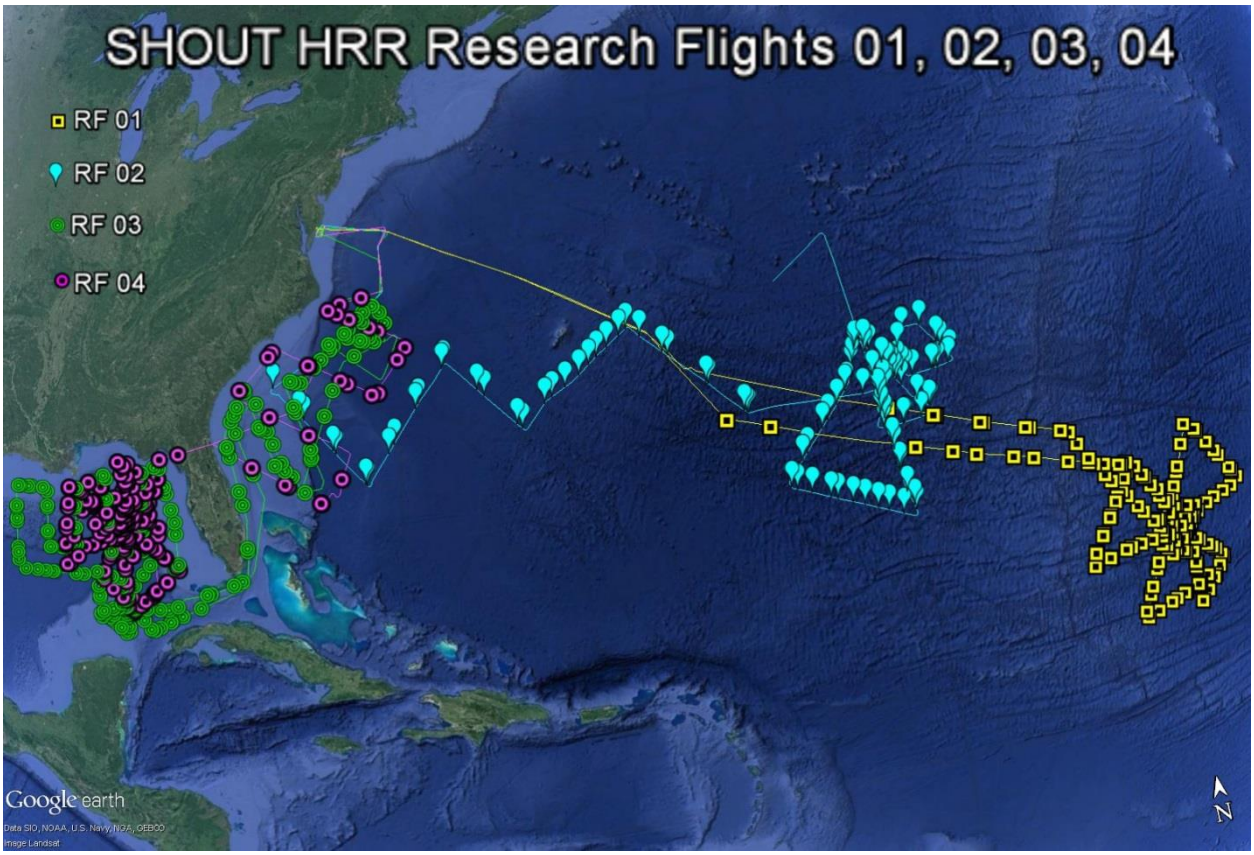

Figure 1 Map of Global Hawk flight tracks and dropsonde launch locations from research flights 1-4

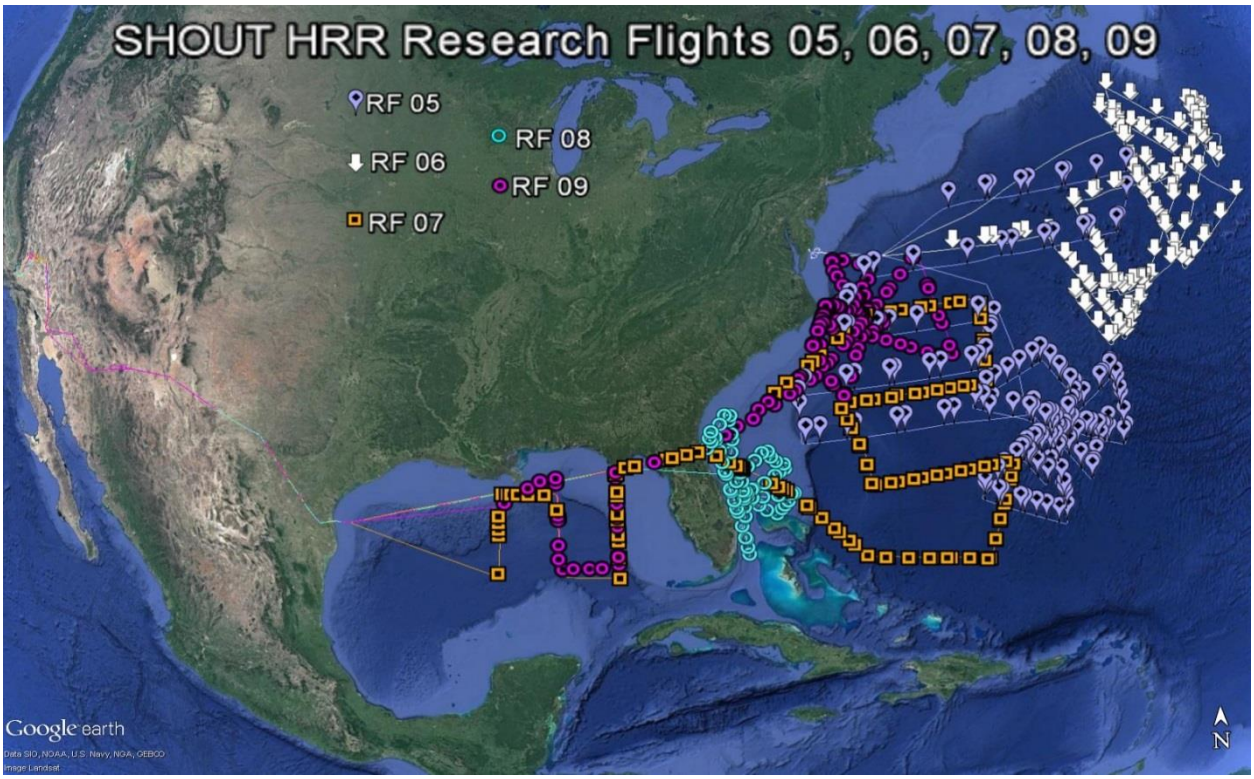

Figure 2 Map of Global Hawk flight tracks and dropsonde launch locations from research flights 5-9.

Table 1. Dropsonde Counts for each Global Hawk Flight

Research/Ferry Flight	Dates	Sondes deployed
RF01	08/24-08/25	81
RF02	08/27	53
RF03	08/28-08/29	89
RF04	09/01	87
RF05	09/22-09/23	82
RF06	09/24-09/25	77
RF07	10/05	60
RF08	10/07	42
RF09	10/09	63
	Total	**634**

II. EOL Sounding File Format and Data Specifics

Information on EOL file naming conventions, metadata header and data parameters is given by Young (2016).

III. Data Quality Control Process

1) The AVAPS software applies a 0.4 hPa dynamic correction, in real time, to the pressure measurements contained in the raw data files.

2) The AVAPS software also applies a dry bias correction in the relative humidity measurements that was discovered, in the Spring of 2016. All sounding files have been corrected for this error and contain the flag, 'TDDryBiasCorrApplied', in the last line of the header to confirm that this correction has been applied. For more information on the dry bias, please see Vömel et al. (2016).

3) A pressure calibration correction is applied to the entire profile for each sounding during the QC process. The pressure correction value is unique for each dropsonde and is determined in the final testing of the dropsonde, during production, at which time an independent reference pressure sensor is used to determine a constant pressure offset correction. The corrected pressure $P = P_{DS} + (P0_{REF} - P0_{DS})$, where P_{DS} is the pressure measured by the dropsonde, $P0_{REF}$ is the pressure as indicated by the reference sensor and $P0_{DS}$ is the dropsonde pressure during calibration testing. This pressure correction is on average -0.80 hPa (Figure 3). This correction is not implemented in real-time data in the field.

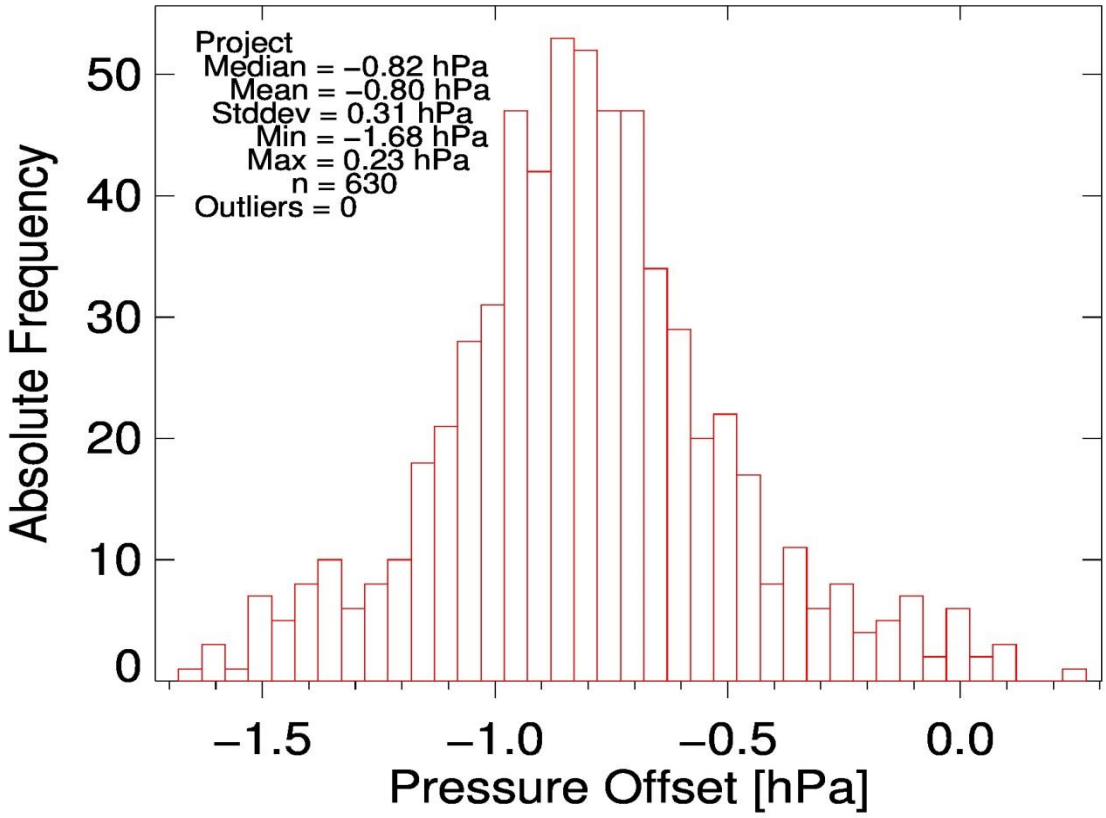

Figure 3 Frequency histogram of pressure correction applied to dropsonde profiles

4) All dropsonde GPS altitude measurements have been improved by removing an existing real-time geoid correction and replacing it with a more accurate geoid height from the Earth Gravitational Model 1996 (EGM96). On average the difference between the two is approximately 1.6 m, but the scatter is quite significant, making this correction necessary.

5) Filtering of the GPS latitude, longitude and altitude is performed to remove spikes introduced by telemetry errors.

6) The sounding files with the corrected pressure offset and filtered GPS data are then processed through the Batch Atmospheric Sounding Processing ENvironment (ASPEN) software which:

   i) Applies a dynamic correction for temperature and wind

   ii) Separates wind speed and direction into *u* and *v* components and individually applies QC. If one of the two components fails a test, then the components as well as speed and direction are removed from the QC data.

   iii) Performs smoothing

   i) Performs sensor time response corrections

   ii) Removes suspect data points.

   The ASPEN software version and configuration file used for this program are included in the header of each "QC.eol" sounding file. For more information on ASPEN or to download the software please visit: http://www.eol.ucar.edu/software/aspen

IV. Results

The following issues were found in Table 2. Corrections applied are detailed below.

Table 2 – Summary of Data Quality Issues

Data Quality Issue	# of soundings
No Reference Pressure	2
Data signal lost during flight	3
Data signal lost briefly and then recovered	2
Bad T/ RH	2

1. **No Reference Pressure –** Two dropsondes, D20160830_174712 and D20161007_191018, inadvertently terminated early due to system or power failure. As a result, the data files were missing the independent, high precision, reference pressure measurement used for the

pressure correction. To correct these, the median pressure correction value, -0.82 hPa, was used.

Data Loss to Surface - There were three soundings classified as dropsondes that did not transmit useful data to the surface, and two soundings that lost data transmission, briefly, but recovered before reaching surface (Figure 4). The gaps of missing data were significant enough that the computed geopotential altitude profiles are incomplete. For sounding file D20160824_173502, altitude was computed from the surface upward to 6545.19 m. For D20160824_172648, altitude is integrated downward from flight level to 754 m. (Figure 5).

Geopot Alt Not to Surface	Lowest Computed Geopotential Alt (m)	Lowest Measured GPS Alt (m)	Integration Direction
D20160824_172648*	754.22	12.66	Downward
D20160824_173502*	0 m	19.84	Upward
D20160830_174712	4789.36	4977.09	Downward
D20160923_001358	1639.55	1673.04	Downward
D20160925_085827	1950.94	2038.04	Downward

*****Contained gap of missing PTU data, but recovered before reaching surface.

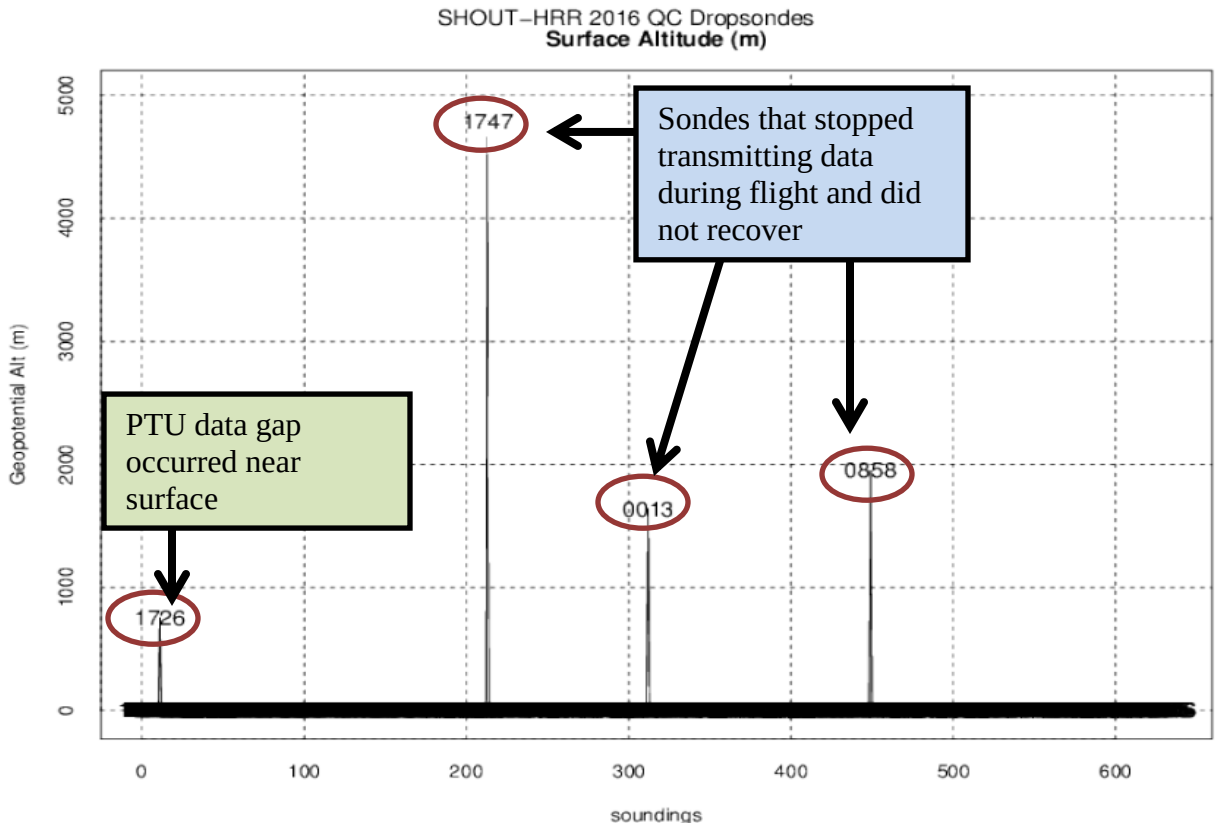

Figure 4 Shows 4 soundings which contain missing geopotential altitude to the surface. These are indicated by a circled timestamp (hour, minute) showing last available geopotential altitudes computed from flight level downward.

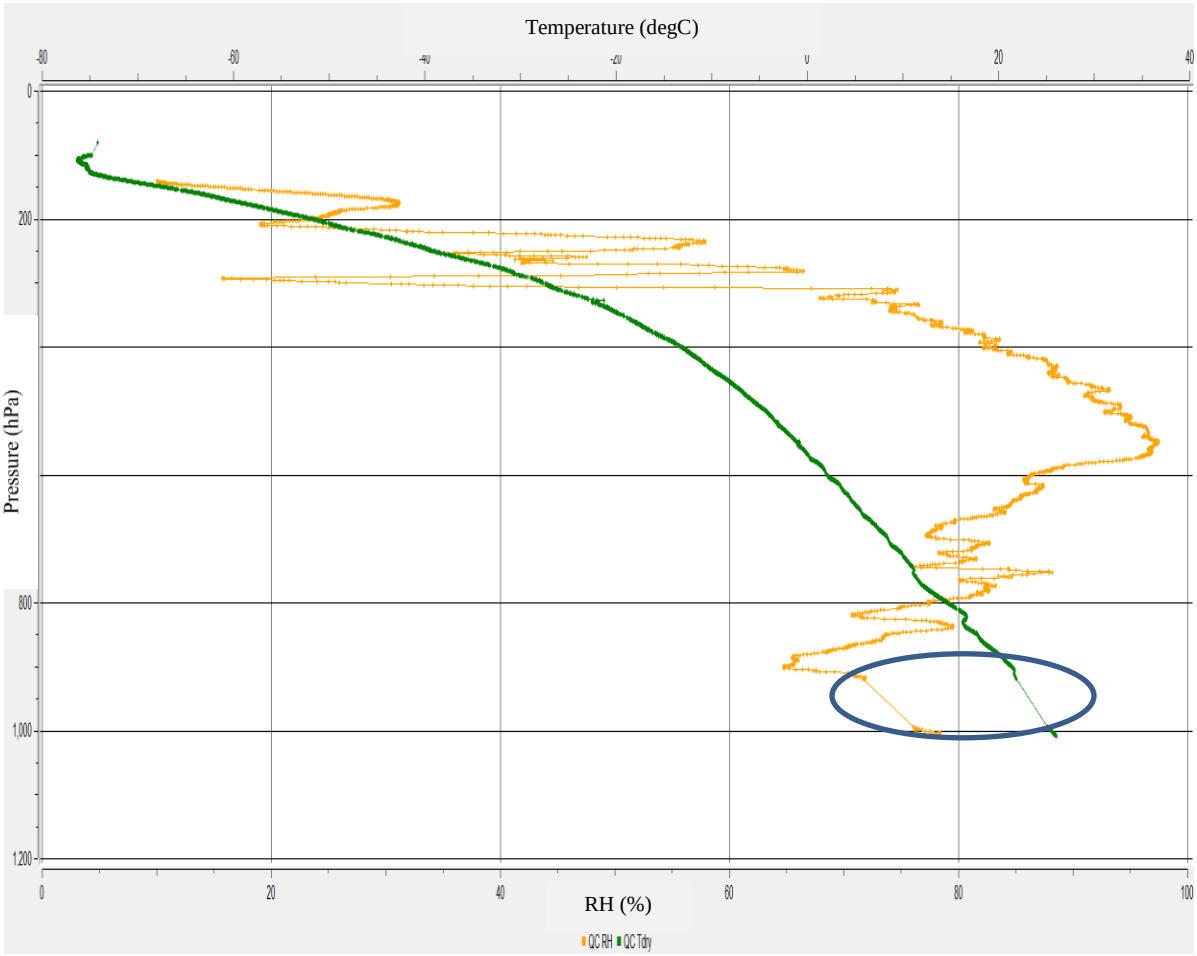

Figure 5 Dropsonde profile, D20160824_172648, shows temperature (degC) and RH (%) versus pressure (hPa) and contains a brief gap of missing PTU data (blue circle), significant enough to interrupt the geopotential altitude calculation.

2. **Bad T/RH –** One dropsonde, D20161009_143926, contained poor RH measurements, over the whole profile, and noisy temperature measurements between 869 hPa and 495 hPa. These values were set to missing. In a second file, D20161009_091519, one of the two RH sensors was heavily biased. These data were also set to missing.

References

Young, K., Vömel, H. (2016, Dec. 09). *EOL Sounding File Format.* Retrieved from https://www.eol.ucar.edu/system/files/files/observing_facility/AVAPS%20Dropsonde%20System/EOLSoundingDataFileFormat.v2_0.pdf

Vömel, H., K. Young, and T. F. Hock, 2016: *NCAR GPS Dropsonde Humidity Dry Bias*. NCAR Technical Note NCAR/TN-531+STR, 8 pp, doi:10.5065/D6XS5SGX. (http://opensky.ucar.edu/islandora/object/technotes:542)